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ON THE GILA NATIONAL FOREST,
NEW MEXICO

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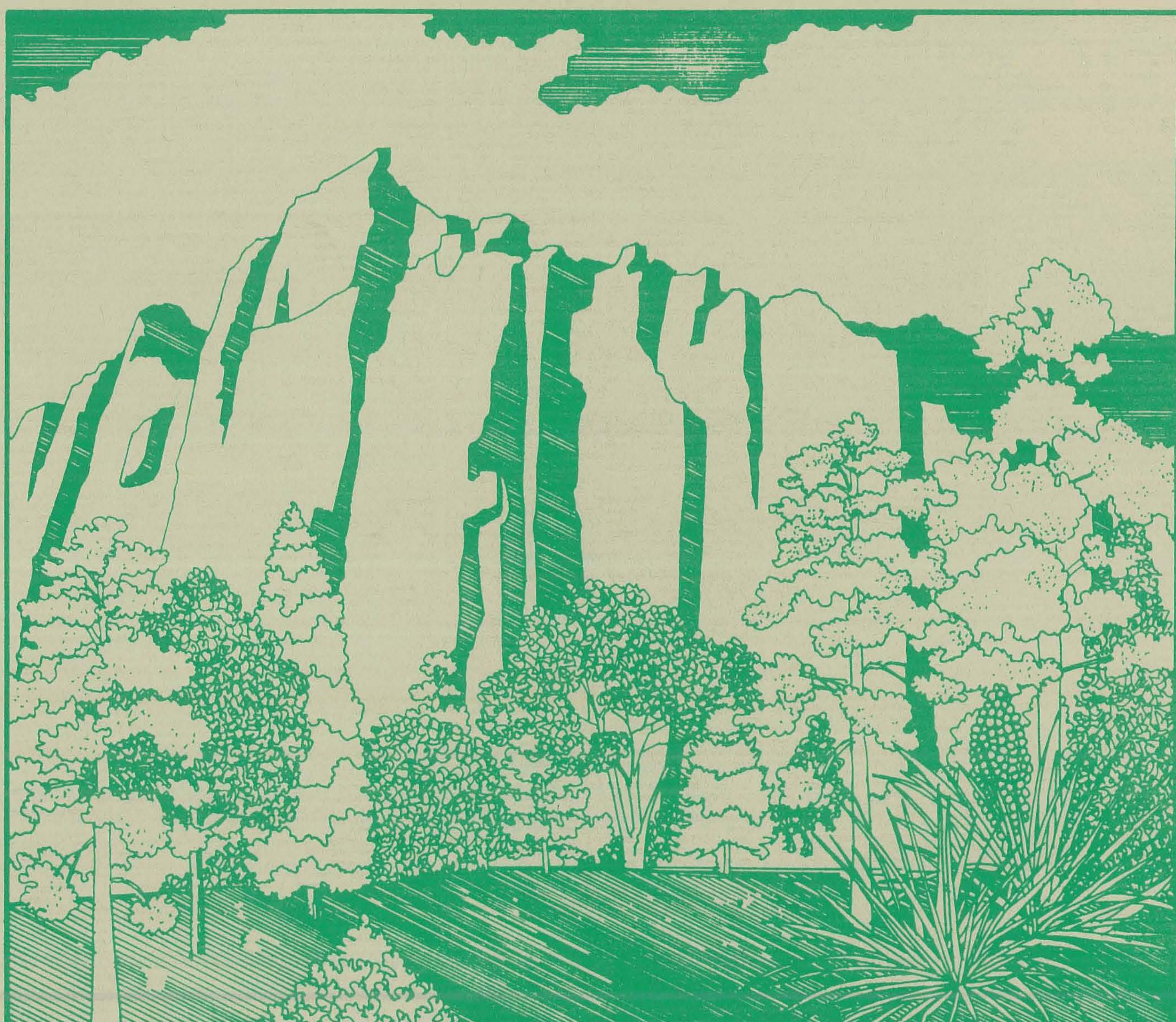

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INCIDENCE, SEVERITY, AND GROWTH LOSSES ASSOCIATED WITH PONDEROSA PINE DWARF MISTLETOE ON THE GILA NATIONAL FOREST, NEW MEXICO

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ABSTRACT

Forest stands adjacent to 419 miles of forest road were surveyed on the Gila National Forest in 1987 to determine the incidence and severity of dwarf mistletoe infection in the commercial ponderosa pine forest cover type. The survey data provided a basis for estimating the magnitude of growth losses associated with dwarf mistletoe. Forty percent of the stocked surveyed stands had infected trees. Of the stands with dwarf mistletoe, 39 percent had less than one-third of the trees in the managed age class infected, 21 percent had one to two-thirds of the trees infected, and 40 percent of the stands had more than two-thirds of the trees in the managed age class infected. Forest-wide, 6,704 acres were surveyed; survey miles and acres were distributed proportionally across all districts and visual quality classes. The seedling and sapling component was under-represented by the survey. Chi-square analyses indicated there was no significant difference in dwarf mistletoe incidence with respect to size or visual quality class in the District and Forest-wide analyses except on the Luna Ranger District where the 3M visual quality class had a significantly higher incidence than the other visual quality classes.

A previous Region-wide dwarf mistletoe roadside survey, conducted between 1954-57 Andrews and Daniels over the same general area, indicated that 23 percent of the ponderosa pine type on the Gila National Forest was infected with dwarf mistletoe. Results from the 1987 survey indicate that dwarf mistletoe has almost doubled. At present, dwarf mistletoe incidence on the Forest is slightly over the estimated Regional average.

Total growth losses were estimated using incidence and severity data from the 1987 survey and RMYLD2 growth and yield simulations. When timber management, silviculture, and dwarf mistletoe control were simultaneously optimized in the simulations, the most conservative estimate of annual loss in sawtimber at the current level of incidence was 16.1 MMBF per year. The corresponding annual loss estimate in pulpwood yield was 3.1 MMCF per year. Small changes in data input into RMYLD2 reflecting changes in timber management emphasis (i.e., focus on nontimber resource objectives), silvicultural prescriptions, and dwarf mistletoe control cutting methods, produced large increases in the annual loss estimates. Delayed stand entries produced equally large increases in the annual loss estimates. We estimate the annual losses in sawtimber growth and yield to be as high as 48 MMBF and 9 MMCF, respectively.

INTRODUCTION

Rocky Mountain ponderosa pine (Pinus ponderosa var. scopulorum) grows on an estimated 11 million acres in the Southwestern United States. In Arizona and New Mexico, 2.5 million acres are regarded as being commercially productive (growth $\geq$ 20 cubic feet per acre per year). On the Gila National Forest, 88 percent of the acres of commercial timberland are in the ponderosa pine forest cover type.

Region-wide, over one-third (36%) of the commercial ponderosa pine resource is dwarf mistletoe infected (Arceuthobium vaginatum subsp. cryptopodum (Engelm.) Hawks. and Wiens); by Forest, estimates of infection levels range from 15 percent to 64 percent (Andrews and Daniels 1960). Volume losses associated with ponderosa pine dwarf mistletoe are primarily growth losses. By comparison, losses caused by other important disease pests of ponderosa pine,

most notably the root rot pathogens Armillaria sp. and Heterobasidion annosum, are related to tree mortality.

Various silvicultural operations involving the cutting and removal of trees are considered the best way of reducing losses to dwarf mistletoe (Hawksworth 1978). In order to apply these operations most effectively, however, the land manager must know: (1) The location and amount of disease, (2) whether this amount is increasing, decreasing, or staying the same, (3) how much loss might be expected given optimal use of the silvicultural procedures, and (4) how much more loss might be expected if proper mistletoe management practices are ignored.

In order to help provide this information to the Gila National Forest, the objectives of this evaluation were to: (1) Document and compare dwarf mistletoe incidence and severity by District and size class on the Gila National Forest, (2) compare the incidence of dwarf mistletoe to that found 30 years ago, (3) compare incidence and severity of stands under different levels of management restriction, and (4) estimate annual growth losses caused by ponderosa pine dwarf mistletoe by Ranger District and Forest-wide.

In addition to documenting mistletoe incidence, severity, and associated growth losses, it is the intent of this report to discuss principle causes of the mistletoe problem and ways to reduce the current level of incidence on the Forest.

METHODS

Incidence and Severity by District and Size

Incidence and severity of dwarf mistletoe were measured using the roadside survey methods of Andrews and Daniels (1960), Merrill et al. (1985), and Johnson et al. (1984). Roadside survey-sampling methods were deemed appropriate to this problem analysis, since the presence of dwarf mistletoe and roads are not thought to be correlated in the Southwest. Two-person crews drove selected roads at speeds not exceeding 10 miles per hour and observed a strip 2 chains wide, measured from the edge of the right-of-way, parallel to the right side of the road. Changes in forest cover type, stand size class, and dwarf mistletoe infection severity were visually estimated and recorded to the nearest 0.10 mile using the survey vehicle odometer. All passable National Forest System roads on each Ranger District were surveyed. Mistletoe data were collected only from acres of ponderosa pine classified as tentatively suitable in the latest land management planning process. At the beginning of the survey, transects 1 chain wide by 2 chains long, perpendicular to the road axis, were established every mile in which infected and uninfected trees in the managed age class were tallied to correct ocular estimates of infection severity. The number of transects gradually decreased as survey crews developed expertise in estimating infection severity.

Forest cover type and stand size class of stands adjacent to roads were determined from land management planning forest cover type maps. The 16 original stand condition classes (FSH 2409.26d, dated November 1975) were

condensed for simplification into 5 broader stand size classes:

Seedlings and saplings (SS); combining 01, 14, and 15
(>4 inches tall; <5.0 inches d.b.h.)

Poletimber (PT); combining 02, 04, 06, 08, 10, and 12
(5.0 to 8.9 inches d.b.h.)

Sawtimber (ST); combining 03, 05, 07, 09, and 13
(9.0 inches and larger)

Overmature timber (OT); 11
(old growth)

Nonstocked (NS); 16

Dwarf mistletoe (DM) infection severity was measured as follows:

DM0 = No visible infection.

DM1 = Less than one-third of the trees in the managed age class infected.

DM2 = One-third to two-thirds of the trees in the managed age class infected.

DM3 = More than two-thirds of the trees in the managed age class infected.

Survey results were expressed as the ratio of miles traveled adjacent to infected stands to the total miles traveled Forest-wide, by District, stand size class, and dwarf mistletoe infection severity level. A record of the roads surveyed and direction traveled for each road can be found in Figures 6-10 of the Appendix.

Chi-square analyses were used to compare the observed and expected (Forest-wide mistletoe incidence) mistletoe infection levels by stand size class. Comparisons were first made on the District level, then on the Forest level.

Comparison to 1956-1957 Roadside Survey

To compare the Forest-wide incidence of dwarf mistletoe on the ponderosa pine type to its incidence 30 years ago, the results of the 1987 roadside survey were compared to the unpublished results of a similar survey of the Gila National Forest conducted by Andrews and Daniels in 1956 and 1957. Maps of surveyed miles from the 1956-1957 study were compared to see how they corresponded with the roads and number of miles we surveyed.

Incidence, Severity, and Management Restrictions

In order to assess the possible correlation of dwarf mistletoe incidence and severity with restricted management areas, visual quality classes (VQO) were also measured along with the other factors. Sensitivity levels and visual quality objectives (FSM 2382.21, Agriculture Handbook No. 462, FSM 2383.4) were combined to reduce the number of classes, since management practices do not

change significantly between some levels. The seven combined classes were:

1. Foreground Retention (FR)
2. Other Retention (OR)
3. Foreground Partial Retention (FPR)
4. Level 3 Partial Retention (3PR)
5. Other Partial Retention (OPR)
6. Level 3 Modification (3M)
7. Other Modification (OM)

The most restrictive visual quality class is the foreground retention class. We might expect that dwarf mistletoe incidence in stands of this VQO would be greatest because they are usually not entered for management, in order to retain their visual integrity. This hypothesis was tested by comparing incidence and severity between VQO classes using the Chi-Square analysis (alpha = .05). Comparisons were first made on the District level, then on the Forest level.

Visual resource inventory maps (scale 2.64 or 2.0 inches = 1 mile) were used to indicate current boundaries of visual quality areas. Changes in forest cover type, stand size class, and visual quality class were clearly marked on survey maps and those maps are archived as a permanent record of the survey.

<u>Growth Loss Estimates</u>

If all stands on the Forests were mistletoe free, that would represent full volume productivity or potential. It is not now, nor will it ever be, feasible to achieve this standard. It is feasible, however, to reduce mistletoe infection severity in stands so that impact on full volume productivity is negligible. The comparison of full productive potential to existing conditions is useful for assessing the magnitude of the problem. In generating sawtimber and pulpwood volume loss estimates, stands representative of three stand size classes (i.e., seedlings and saplings, poletimber, and sawtimber, were projected to rotation age (120 years) under four infection severity levels using RMYLD2 (Edminster 1978)).

Each stand size class was assigned a nominal age:

Seedlings and Saplings	= 20 years
Poletimber	= 50 years
Sawtimber	= 100 years

Site index values of 60, 70, and 80 feet (100-year index age) were used in the growth and yield simulations to reflect the range of conditions existing on the Forest. Growing stock levels (GSLs) were adjusted whenever possible to reflect site productivity, optimize volume production and product size, and achieve effective dwarf mistletoe control. Differences in yield for stands managed to

rotation at each infection severity level represented the impact on volume production attributable to dwarf mistletoe. RMYLD2 output was expressed in yield per acre; losses were assessed by subtracting yields of stands with mistletoe from healthy stand yields. Losses were reported for each District surveyed by stand size class. Acres of suitable Forest land by forest cover type, stand size class, and site index were obtained from the 1985 inventory. According to the 1985 inventory, there are a total of 482,400 stocked acres of commercial ponderosa pine on the Gila National Forest. Listed below is an estimated breakdown of the 482,400 acres by size class:

Seedlings and Saplings	=	67,536	acres (14%)
Poletimber	=	159,192	acres (33%)
Sawtimber	=	255,672	acres (53%)

Seedling and sapling, and poletimber stands were managed to a 120-year rotation age beginning at 20 and 50 years, respectively. For sawtimber stands, future growth losses to dwarf mistletoe were considered minor since stand regeneration was imminent. In these stands, the understory seedling and sapling component was managed to rotation on RMYLD2. The underlying assumption used in sawtimber simulations was equivalent infection levels in the overstory and understory components. Optimum silvicultural prescriptions by site index, stand size class, and dwarf mistletoe infection severity level are shown in Tables 1 and 2.

For all RMYLD2 simulations, dwarf mistletoe infection severity levels were set at the midpoint of their range:

DM0 = no infection = PINF 0

DM1 = 16.5 percent infection = PINF 16.5

DM2 = 49.5 percent infection = PINF 49.5

DM3 = 82.5 percent infection = PINF 82.5

(PINF is the equivalent RMYLD2 input variable)

To arrive at estimates of potential volume production for DM3 = 82.5 percent infection, DMLEV was set at 6.0 (DMLEV is the input variable in RMYLD2 that indicates the dwarf mistletoe rating (DMR) above which thinnings will not be performed (Edminster 1978, Hawksworth 1977)).

RESULTS

Incidence and Severity by District and Size Class

A total of 6,704 stocked acres were surveyed, equivalent to a 1 percent sampling intensity. The largest percent of total surveyed area was in the Reserve Ranger District (39%), the least within the Glenwood Ranger District (2%).

Sampling intensity of each District was roughly proportional to the percent of

total acres of ponderosa pine type represented by the District. According to estimates provided by each of the districts, 7%, 3%, 11%, 3%, 17%, 55%, and 4% of the total stocked commercial acres of ponderosa pine were represented by the Black Range, Glenwood, Luna, Mimbres, Quemado, Reserve, and Silver City Ranger Districts, respectively. The seedling and sapling size component was under-represented, however. According to the forest inventory, 14%, 33%, and 53% of the total stocked acres are represented by seedlings and saplings, poles, and sawtimber, respectively while, of the surveyed miles, 1%, 24%, and 74% were adjacent seedlings and saplings, poles, and sawtimber stands, respectively.

Dwarf mistletoe was found on 40 percent of the surveyed stocked acres of ponderosa pine on the Gila National Forest. Of the 419 miles surveyed, 0 were adjacent to nonstocked stands, 167 to stands with mistletoe infected trees, and 252 to mistletoe-free stands. Mistletoe incidence was estimated as greatest on the Glenwood Ranger District (67%) and least on the Mimbres Ranger District (24%). The greatest percent of total acres with heavily infected trees was found on the Black Range Ranger District (27%) while the least heavily infected trees were found on the Luna Ranger District (8%). Table 3 and Figure 1 show distribution of surveyed acres on a District by dwarf mistletoe incidence and severity classes. Table 4 shows the results of the survey by District, severity class, and size class. No significant difference (P>.05) could be demonstrated between dwarf mistletoe incidence on seedlings and saplings, poletimber, and sawtimber either on the District or on the Forest level (Table 5 and Figure 2).

Comparison with 1957 Roadside Survey

The Forest-wide estimate of dwarf mistletoe incidence (40%) determined by this survey was much greater than the estimated incidence found in 1956-57 (23%). Twenty nine percent more miles of roads were surveyed in the 1987 roadside survey than in 1956-57 because the New Mexico portion of the Apache National Forest (administered by the Gila National Forest) was not included in the older survey. Incidence along roads corresponding to those surveyed by Andrews and Daniels was, therefore, calculated to determine if the higher incidence of the 1987 survey was due to the miles of commercial forest not included in the 1956-57 survey. Incidence along roads of the 1987 survey corresponding those surveyed in the 1956-57 was the same (40%) as the Forest-wide incidence. The higher estimated incidence, therefore, reflected a true increase in mistletoe not the inclusion of extra area in the survey (Figure 5). Roadside survey techniques of Andrews and Daniels (1960) appeared comparable to the techniques of the present survey.

Incidence, Severity, and Management Restrictions

There was no significant difference between dwarf mistletoe incidence (P>.05) and visual quality class either at the District level or the Forest level except on the Luna Ranger District where the OM visual quality class had significantly higher incidence than the other visual quality classes (Table 5).

Growth Loss Estimates

Estimates of annual growth loss by District are summarized in Table 6. These

estimates are not based on simulating current management conditions, but are an expression of growth losses to dwarf mistletoe under optimal management ie., when silviculture and dwarf mistletoe control are optimized coincidentally and all stands with mistletoe are entered immediately. Including all size classes in the calculations, a sawtimber loss estimate of 16.1 MMBF per year, Forest-wide, is the most conservative estimate when mistletoe incidence is 40 percent. Since all stands cannot be entered immediately, current sawtimber losses on the Gila National Forest probably exceeds the 16.1 MMBF per year and may run as high as 48 MMBF per year. This is confirmed in yield projections that allow delayed entry (Figure 5). A comparable estimate applies to cubic foot volume losses as well (i.e., 3.1 to 9 MMCF per year).

DISCUSSION

The results of the 1987 survey of the Gila National Forest indicate that, Forest-wide, dwarf mistletoe incidence has increased considerably in the ponderosa pine type. This increase in incidence may be attributable to a number of factors, including 30 or more years of selective harvesting. The propensity to prescribe preparatory cuts in succession, where seed cuts or final removals were needed has perpetuated uneven-aged stand conditions and may have increased the spread of disease. Past management emphasis was inappropriate to reducing dwarf mistletoe; cutting out the volume was most important.

Given an initially equal distribution of dwarf mistletoe between size and visual quality classes, then, if past silvicultural management practices were significantly reducing the mistletoe on the Gila National Forest, one would expect less mistletoe in the poletimber than in the sawtimber, and, less mistletoe in the less restrictive management classes than in the more restrictive management classes. One would also expect the level of incidence found on the current roadside survey to be less than the 1957 roadside survey. Because neither was the case, the current dwarf mistletoe problem on the Gila National Forest is worthy of attention, especially since the level of incidence is easily regulated, in most cases, with appropriate cutting methods (Edminster 1978, Hawksworth 1978). Management objectives should reflect a concerted effort to reduce dwarf mistletoe effects on growth and yield. Unchecked, the present mistletoe problem may worsen and the magnitude of associated growth losses, according to our RMYLD2 simulations, may increase. At the very least, it appears that under the management practices of the past 30 years, the mistletoe problem will not improve.

Given a mistletoe infested overstory, mistletoe is thought to spread most slowly in single-story, even-aged stands of any age than in two-storied or all aged stands (Hawksworth 1961). Thus, departures from even-aged management could result in increases in dwarf mistletoe spread and intensification. In the RMYLD2 growth and yield simulations that were used to estimate volume losses, stocking was drastically reduced in stands with mistletoe at the earliest possible time to reduce incidence and severity. Without this early reduction in stocking, stands were destroyed by dwarf mistletoe before rotation age. Volume loss estimates assume that thinning entries or regeneration cuts were made in every stand at the most opportune time. Departures from this management strategy resulted in much greater yield loss projections.

As previously stated in the introduction, in addition to documenting mistletoe

incidence, severity, and associated estimated growth losses, we would like to suggest possible causes of the mistletoe problem, and corrective timber management practices aimed at reducing the current level of incidence on the Forest:

1. A repeated history of selective harvesting in stands with dwarf mistletoe infected trees.

2. Silvicultural prescriptions that perpetuated uneven-aged stand conditions. The ponderosa pine cover type consisted of a mosaic of uneven-aged clumps of trees. Following selective overstory removals, portions of every stand were naturally regenerated. Seed cuts were rare and total overstory removals almost nonexistent.

3. Lack of priority given to treating mistletoe. Entire timber sale areas were selectively harvested to produce a targeted volume. Little thought was given to delineating specific cutting units for the primary purpose of controlling dwarf mistletoe. By giving stands with mistletoe high treatment priority in timber sales, two major works could be accomplished: (a) The targeted volume could be realized from fewer acres, and (b) greater volume would be produced in properly treated stands that could be harvested in subsequent entries.

4. Ineffective cutting methods when dwarf mistletoe was the intended object of silvicultural prescriptions. Visibly infected overstory trees were removed, but trees with little evidence of witches broom formation were retained in the overstory. Seeds discharged from mistletoe plants in the residual overstory trees provided the inoculum source for further overstory and understory infections. In most cases, a seed cut and overstory removal, followed by judicious thinning in the understory, would have reduced the presence of the dwarf mistletoe in stands to acceptable levels.

5. Lack of consistency in controlling dwarf mistletoe in stands of any size class.

6. Lack of consistency in controlling dwarf mistletoe in stands of any visual quality class.

The growth losses estimated and presented reflect the level of damage and loss associated with mistletoe at the present level of incidence. Losses will decrease with reductions in the number and distribution of infected trees in stands. The solution to the problem lies in improving stand management by treating infected stands first, thereby reducing mistletoe incidence in stands, one stand at a time. It is important that mistletoe incidence routinely becomes a major decision variable when stand treatments are prioritized and cutting units are selected in timber sales. Prescriptions need to reflect a major emphasis on reducing incidence and severity of dwarf mistletoe, while trying to reflect stocking, spacing, and tree diameter objectives. Dwarf mistletoe is endemic in southwestern ponderosa pine forests, but its impact can be reduced with proper management so that the effects are negligible.

Chapter 70 in the Cutting Methods Handbook (1985) has been prepared as a field aid for dealing with stands with dwarf mistletoe. Information is given on rating infected trees and whole stands, and methods are presented which aid in the complex process of determining which cutting units should be entered and

which can be deferred. Sections on regeneration and intermediate cutting methods are also included. Much of the time these materials will provide the necessary guidance. If additional technical assistance is needed, Pathologists in the Regional Office are available to help evaluate mistletoe problems and assist in formulating prescriptions to control dwarf mistletoe in specific cutting units.

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APPENDIX

TABLE 1--Optimum prescriptions for RMYLD2 growth and yield simulations for the Gila National Forest seedlings and saplings (SS).

SSC[1]	AGE (YRS)	SITE INDEX	DMR[2] START (0-6)	PINF[2] START %	DMR[3] FINAL (0-6)	THIN1[2] (GSL)	DSTY1[2] (GSL)	DSTY2[2] (GSL)	DBH[3] CUT (IN)	DBH[3] RESID. (IN)	VOLUME OUT[3] MBF/AC	VOLUME OUT[3] MCF/AC	CULM. MAI[4] AGE (YRS)	CULM. MAI[4] FT[3]
SS	20	60	0	0	0	60	60	60	19.1	16.6	15.1	3.5	100	27
			0.2	16.5	0.4	40	40	40	21.7	19.7	11.8	2.8	90	22
			0.7	49.5	0.1	20	40	40	21.9	19.7	10.9	2.5	90	19
(Regenerate)[5]			2.6	82.5	6.0	20	20	20	21.4	21.3	0.6	0.1	70	8
SS	20	70	0	0	0	60	70	70	19.3	16.7	20.3	4.6	100	36
			0.2	16.5	0.1	40	60	60	20.4	17.8	17.6	4.0	100	31
			0.7	49.5	0.4	40	40	40	22.9	20.7	13.7	3.2	90	25
(Regenerate)			2.6	82.5	5.5	20	20	20	23.5	23.4	4.0	1.0	80	12
SS	20	80	0	0	0	60	70	70	20.5	18.0	25.3	5.6	100	43
			0.2	16.5	0.1	40	60	60	20.1	19.1	21.9	4.8	100	37
			0.7	49.5	0.3	40	50	50	22.6	20.3	19.4	4.3	90	33
(Regenerate)			2.6	82.5	4.8	20	20	20	26.2	25.8	7.8	1.7	80	15

[1] SSC is stand size class.

[2] Input variables for data entry into RMYLD2; DMR START=DMR(1) stand dwarf mistletoe rating; PINF START=PINF(1) percent mistletoe infected; THIN1=growing stock level achieved with initial thinning; DSTY1 and 2=growing stock level or density achieved with subsequent entries. (Edminster 1978)

[3] Output from RMYLD2; DMR FINAL=stand dwarf mistletoe rating at rotation; DBH CUT=average diameter of sawtimber cut during the seed cut; DBH RESID.=average seed tree diameter; VOLUME OUT=commercial volume produced per acre.

[4] Culmination of mean annual increment.

[5] Unable to reduce dwarf mistletoe to acceptable levels; regenerate the stand.

TABLE 2--Optimum prescriptions for RMYLD2 growth and yield simulations for the Gila National Forest poletimber (PT).

SSC[1]	AGE (yrs)	SITE INDEX	DMR[2] START (0-6)	PINF[2] START %	DMR[3] FINAL (0-6)	THIN1[2] (GSL)	DSTY1[2] (GSL)	DSTY2[2] (GSL)	DBH[3] CUT (in)	DBH[3] RESID. (in)	VOLUME OUT[3] MBF/AC	VOLUME OUT[3] MCF/AC	CULM.MAI[4] AGE (yrs)	CULM.MAI[4] ft^3
PT	50	60	0	0	0	60	60	60	19.5	16.8	14.8	3.4	120	25
			0.2	16.5	0.1	40	50	50	19.3	16.7	12.1	3.1	110	22
			0.7	49.5	0.1	40	50	50	19.3	16.7	12.1	3.1	110	22
(Regenerate)[5]			2.6	82.5	4.5	20	20	20	22.3	21.7	4.9	1.5	50	12
PT	50	70	0	0	0	60	70	70	20.0	17.5	19.6	4.4	110	31
			0.2	16.5	0.1	40	60	60	19.5	16.9	16.7	4.0	100	31
			0.7	49.5	0.1	40	60	60	19.5	16.9	16.7	4.0	90	25
(Regenerate)			2.6	82.5	3.9	20	20	20	23.5	22.9	7.0	2.2	80	12
PT	20	80	0	0	0	60	70	70	21.6	19.4	24.1	5.4	100	38
			0.2	16.5	0.1	40	60	60	20.5	18.1	20.0	5.1	110	37
			0.7	49.5	0.1	40	60	60	20.5	18.1	20.0	5.1	110	37
(Regenerate)			2.6	82.5	2.8	20	30	30	23.1	21.7	11.6	3.4	50	26

[1] SSC is stand size class.

[2] Input variables for data entry into RMYLD2; DMR START=DMR(1) stand dwarf mistletoe rating; PINF START=PINF(1) percent mistletoe infected; THIN1=growing stock level achieved with initial thinning; DSTY1 and 2=growing stock level or density achieved with subsequent entries. (Edminster 1978)

[3] Output from RMYLD2; DMR FINAL=stand dwarf mistletoe rating at rotation; DBH CUT=average diameter of sawtimber cut during the seed cut; DBH RESID.=average seed tree diameter; VOLUME OUT=commercial volume produced per acre.

[4] Culmination of mean annual increment.

[5] Unable to reduce dwarf mistletoe to acceptable levels; regenerate the stand.

ABLE 3--Comparison of dwarf mistletoe infection _.verity levels between Districts on the Gila National Forest.

RANGER DISTRICT		DWARF MISTLETOE INFECTION SEVERITY					
		DM(-)[1]	DM(+)[2]	DM1[3]	DM2[3]	DM3[3]	SUBTOTAL
BLACK	MI[4]	21.2	13.3	2.2	1.8	9.3	34.5[5]
RANGE	%[6]	61	39	6	5	27	8[7]
GLENWOOD	MI	3.0	6.2	1.7	3.6	0.9	9.2
	%	33	67	18	39	10	2
LUNA	MI	53.8	41.0	18.5	7.7	14.8	94.8
	%	57	43	20	8	16	23
MIMBRES	MI	11.8	3.8	1.8	0.7	1.3	15.6
	%	76	24	12	4	8	4
QUEMADO	MI	52.9	30.1	15.3	6.9	7.9	83.0
	%	64	36	18	8	10	20
RESERVE	MI	101.4	61.3	20.7	13.0	27.6	162.7
	%	62	38	13	8	17	39
SILVER	MI	8.2	11.3	4.3	2.1	4.9	19.5
CITY	%	42	58	22	11	25	5
FOREST	MI	252.3	167.0	64.5	35.8	66.7	419.3
TOTAL	%	60	40	15	9	16	100

[1] (-)=Miles of ponderosa pine stands surveyed without dwarf mistletoe infection.

[2] (+)=Miles of ponderosa pine stands surveyed with dwarf mistletoe infection of severity level (1, 2, or 3).

[3] Dwarf mistletoe infection severity level.

[4] Miles surveyed in stands within a District and infection severity level.

[5] Miles surveyed in a District.

[6] Percentage of total miles surveyed in a District within an infection severity level.

[7] Percentage of Forest-wide survey miles.

TABLE 4--Dwarf mistletoe infection severity estimates by stand size class for Districts on the Gila National Forest.

		STAND SIZE CLASS											
		SEEDLINGS/SAPLINGS				POLETIMBER				SAWTIMBER			
RANGER DISTRICT		0	1	2	3[1]	0	1	2	3	0	1	2	3
BLACK RANGE	MI[2]	0.4	0	0	0	2.3	0	0	0.8	18.5	2.2	1.8	8.5
	%[3]	100	0	0	0	74	0	0	26	60	7	6	27
GLENWOOD	MI	0	0	0	0	0.3	1.4	0.6	0	2.7	0.3	3.0	0.9
	%	0	0	0	0	13	61	26	0	39	4	43	13
LUNA	MI	0.2	0	0	0	8.9	3.5	1.9	5.1	44.7	15.0	5.8	9.7
	%	100	0	0	0	46	18	10	26	59	20	8	13
MIMBRES	MI	0	0	0	0	3.5	0	0	0	8.3	1.8	0.7	1.3
	%					100	0	0	0	69	15	6	11
QUEMADO	MI	0.4	0	0	0	11.5	5.2	1.9	2.8	41.0	10.1	5.0	5.1
	%	100	0	0	0	54	24	9	13	67	17	8	8
RESERVE	MI	3.8	0.8	0.3	0	26.9	7.4	3.8	11.9	70.7	12.5	8.9	15.7
	%	78	16	6	0	54	15	8	24	66	12	8	15
SILVER CITY	MI	0	0	0	0	1.2	0.3	0.4	0.5	7.0	4.0	1.7	4.4
	%	0	0	0	0	50	13	17	21	41	23	10	26
FOREST TOTAL	MI	4.8	0.8	0.3	0	54.6	17.8	8.6	21.1	192.9	45.9	26.9	45.6
	%	81	14	5	0	53	17	8	21	62	15	9	15

[1] Dwarf mistletoe infection severity level.

[2] Miles of road surveyed in stands of a particular size class and infection severity level.

[3] Percentages are computed within the stand size for a single District, and are rounded to nearest whole percentage.

TABLE 5--Summary of Chi-square analyses comparing observed and expected mistletoe incidence[1] by stand size classes and visual quality classes (P=0.05).

		STAND SIZE CLASSES			VISUAL QUALITY CLASSES				
RANGER DISTRICT		SS[2]	PT[2]	ST[2]	FR[3]	FPR[3]	OPR[3]	3M[3]	OM[3]
BLACK (O_1-E_1)	MI[4]	-0.2	-0.4	+0.4		-1.3			+1.1
RANGE	SIG[5]	NS	NS	NS		NS			NS
GLENWOOD	MI		+0.5	-0.4		-0.2			+0.2
	SIG		NS	NS		NS			NS
LUNA	MI	-0.1	+2.2	-1.8		-3.3		+5.9	+2.3
	SIG	NS	NS	NS		NS		S	NS
MIMBRES	MI		-0.8	+0.9		+0.8			-0.7
	SIG		NS	NS		NS			NS
QUEMADO	MI	-0.1	+2.2	-1.8	-0.4	-0.3	+0.2	+0.5	+0.3
	SIG	NS	NS	NS	NS	NS	NS	NS	NS
RESERVE	MI	-0.8	+4.1	-3.9		+3.6	+0.9	+1.0	-6.0
	SIG	NS	NS	NS		NS	NS	NS	NS
SILVER CITY	MI		+0.2	+0.2		+0.4	-0.1	+0.2	-1.2
	SIG		NS	NS		NS	NS	NS	NS
FOREST TOTAL	MI	-1.3	+6.7	-5.8	-0.5	-1.1	+1.1	+7.7	-8.4
	SIG	NS	NS	NS	NS	NS	NS	NS	NS

[1] Dwarf mistletoe incidence is presented as miles of stands surveyed with any mistletoe infection, by stand size class, visual quality class, and District.

[2] SS=seedling and sapling stands; PT=poletimber stands; ST=sawtimber stands. OT=overmature stands.

[3] See page 4 for an explanation of abbreviations, no OR or 3PR classes were surveyed.

[4] Difference between the observed (O_1) number of miles of road surveyed with mistletoe infection and the expected (E_1) number of miles with mistletoe infection as predicted by the Chi-square distribution.

[5] Denotes significance at P<0.05; NS is not significant; S is significant.

TABLE 6--Minimum estimate[1] of annual losses in sawtimber and poletimber production on the Gila National Forest.

		SEEDLINGS AND SAPLINGS (SS)		POLETIMBER (PT)		SAWTIMBER (ST)		SUBTOTAL	
RANGER DISTRICT		MMBF/YR	MMCF/YR	MMBF/YR	MMCF/YR	MMBF/YR	MMCF/YR	MMBF/YR	MMCF/YR
BLACK RANGE	VOL.			0.5	0.1	0.9	0.2	1.4	0.3
	%[2]			3	3	6	6	9	10
GLENWOOD	VOL.			0.2	0.0+	0.3	0.1	0.5	0.1
	%			1	0+	2	3	3	3
LUNA	VOL.	0.0+	0.0+	0.2	0.0+	1.5	0.3	1.7	0.3
	%	0+	0+	1	0+	9	10	11	10
MIMBRES	VOL.			0.1	0.0+	0.2	0.1	0.3	0.1
	%			0	0+	1	3	2	3
QUEMADO	VOL.			1.0	0.2	1.0	0.2	2.0	0.4
	%			6	6	6	6	12	13
RESERVE	VOL.	0.3	0.1	5.1	0.8	3.9	0.8	9.3	1.7
	%	2	3	32	26	24	26	58	55
SILVER CITY	VOL.			0.5	0.1	0.4	0.1	0.9	0.2
	%			3	3	2	3	6	6
FOREST TOTAL	VOL.	0.3	0.1	7.6	1.2	8.2	1.7	16.1	3.1
	%	2	0+	47	7	51	11	100	100

1 Estimates based on RMYLD2 growth and yield projections using incidence severity data from the survey.

2 Percentage of District losses in a stand size class.

FIGURE 1. Comparison of DM incidence between Districts on the Gila National Forest

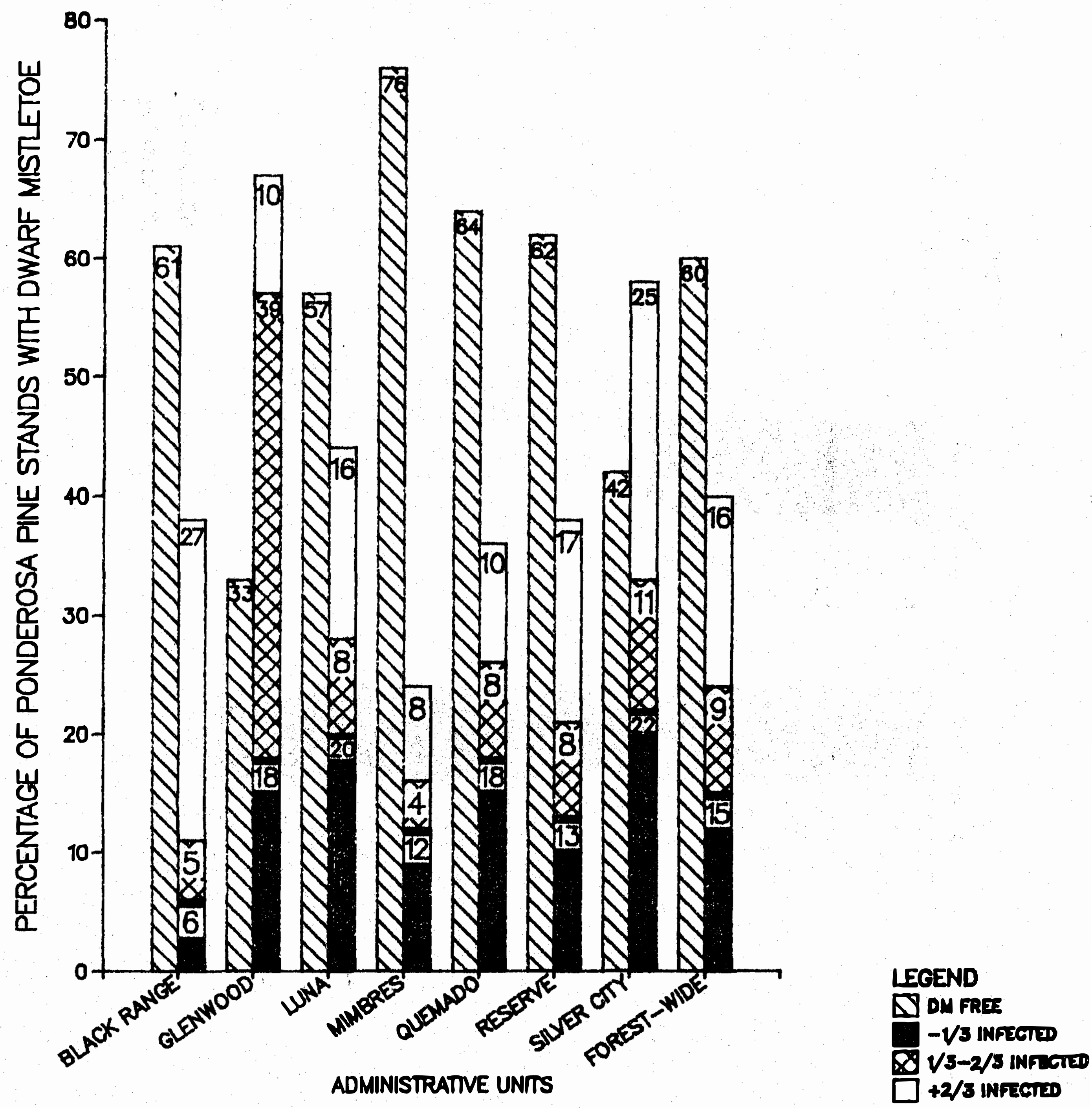


FIGURE 2. Comparison of observed and expected DM incidence by size class for the Gila National Forest

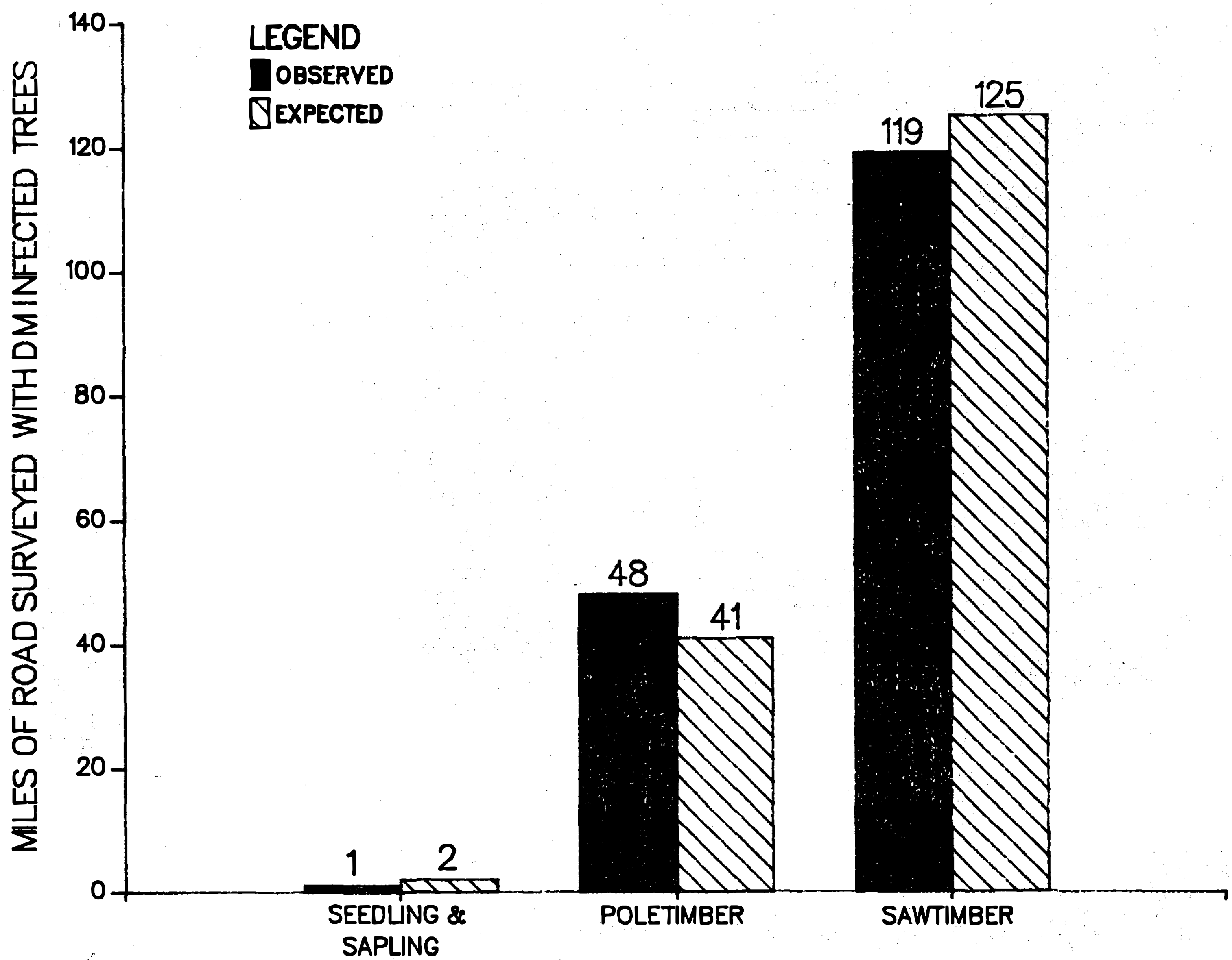


FIGURE 3. Comparison of observed and expected DM incidence by visual quality class for the Gila National Forest

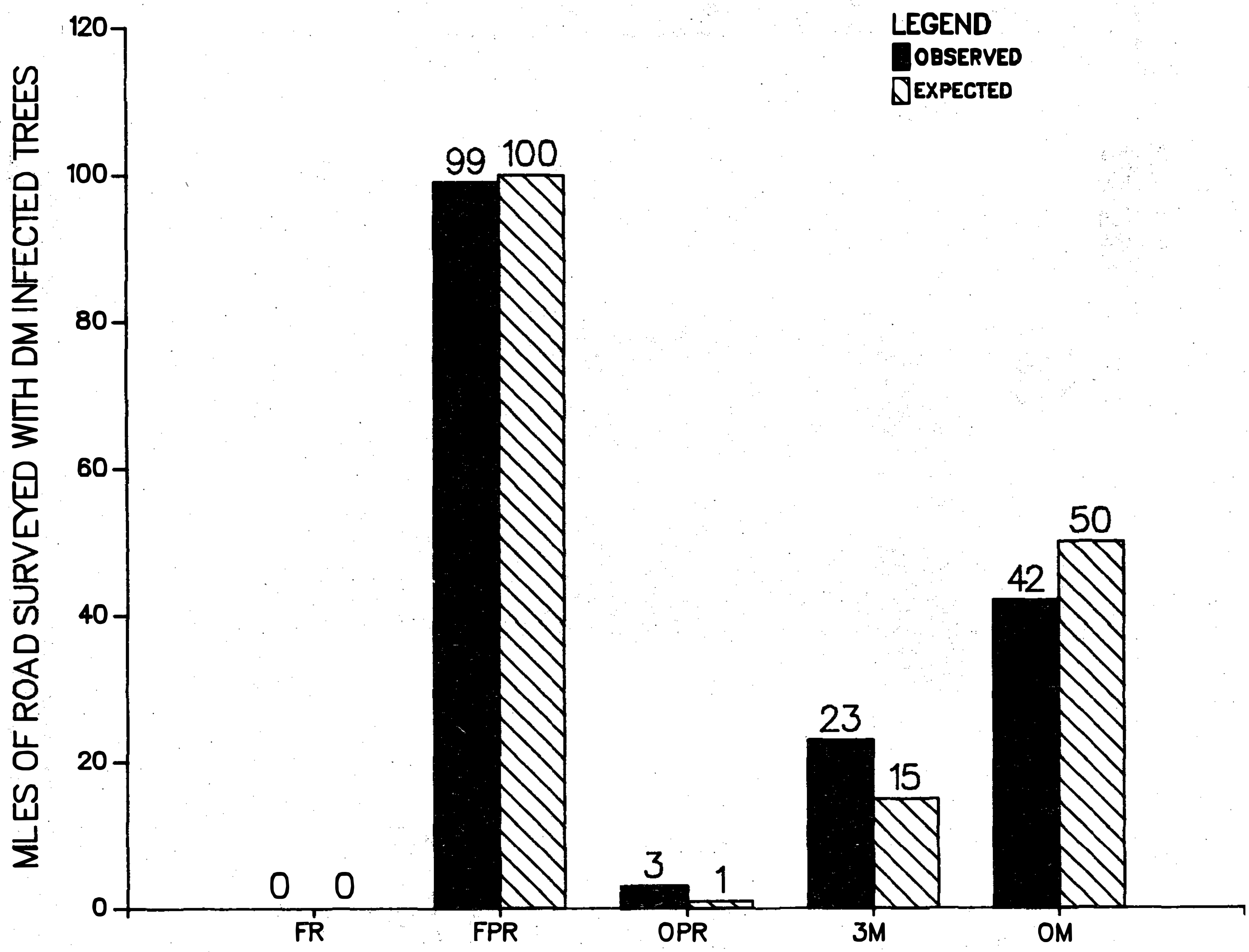


FIGURE 4. Distribution of projected annual volume losses by size class for the Gila National Forest

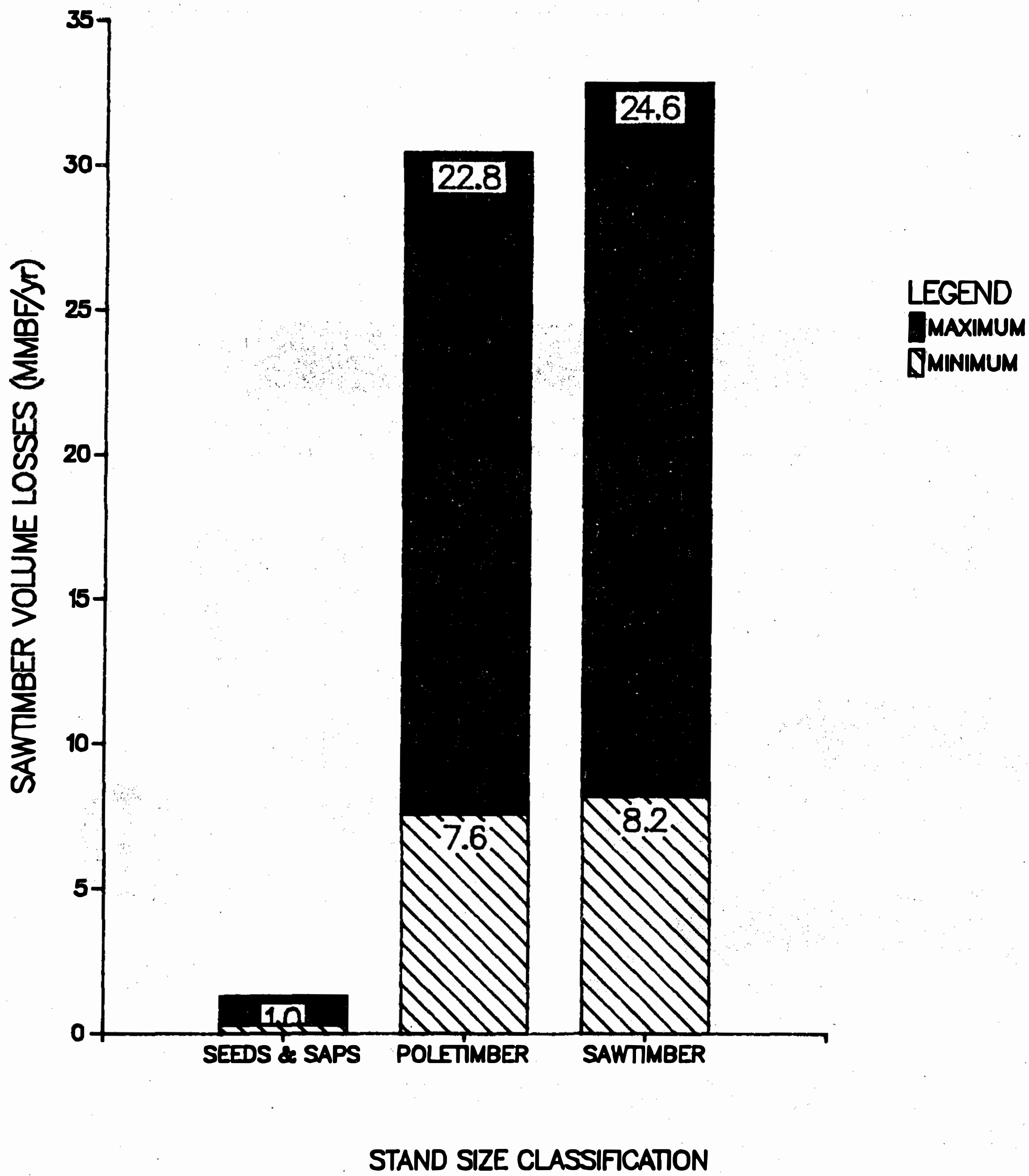
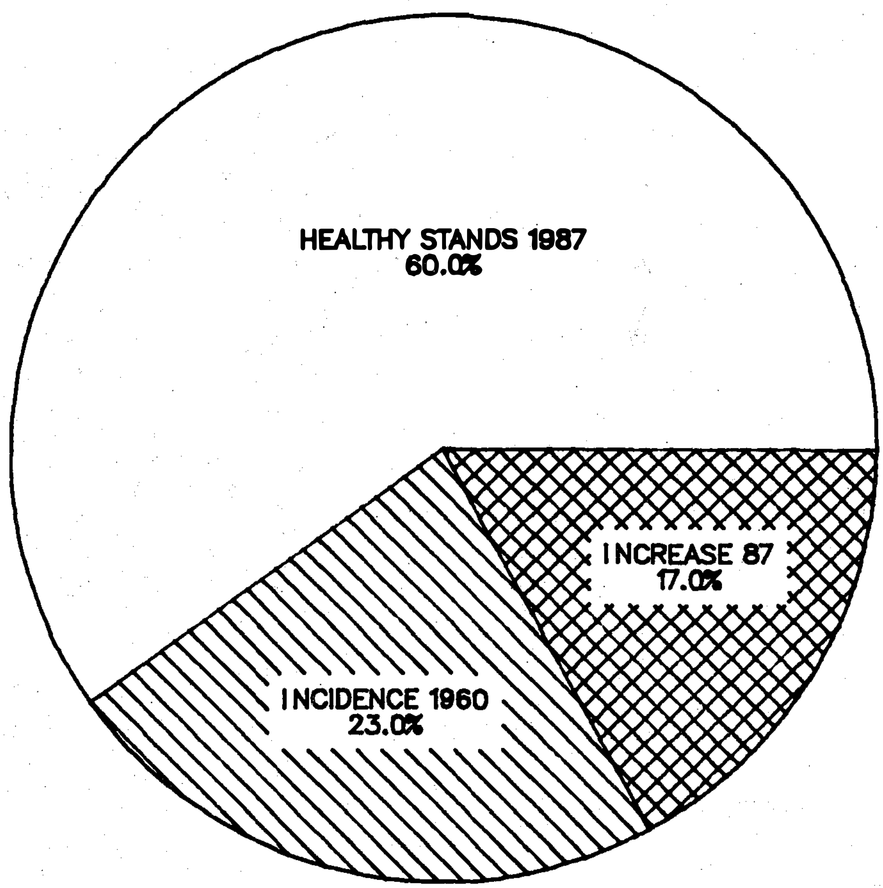
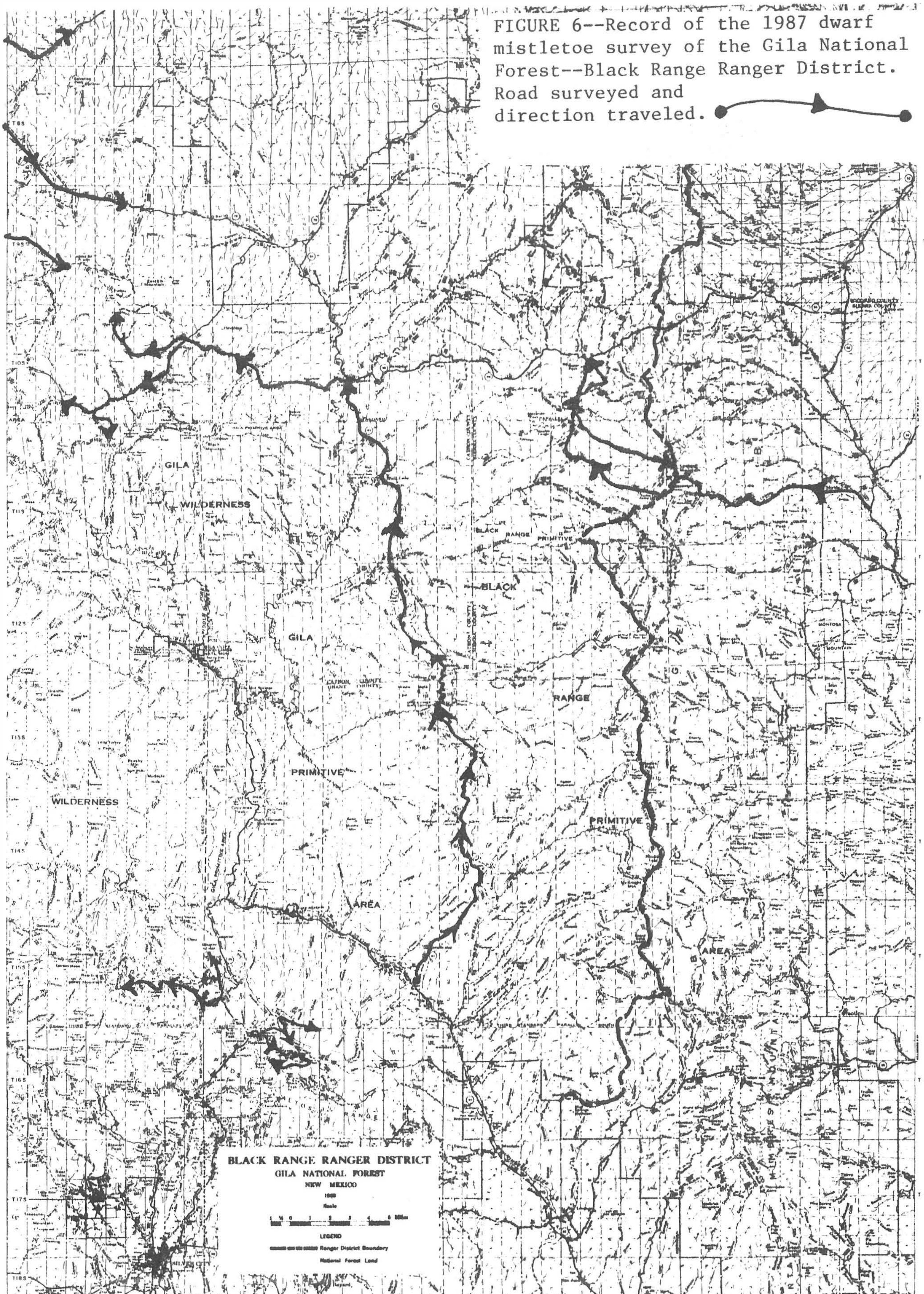


FIGURE 5. Dwarf mistletoe incidence in commercial ponderosa pine stands on the Gila National Forest from 1960–1987



PROPORTION OF TOTAL NO. OF STANDS

FIGURE 6--Record of the 1987 dwarf mistletoe survey of the Gila National Forest--Black Range Ranger District. Road surveyed and direction traveled.



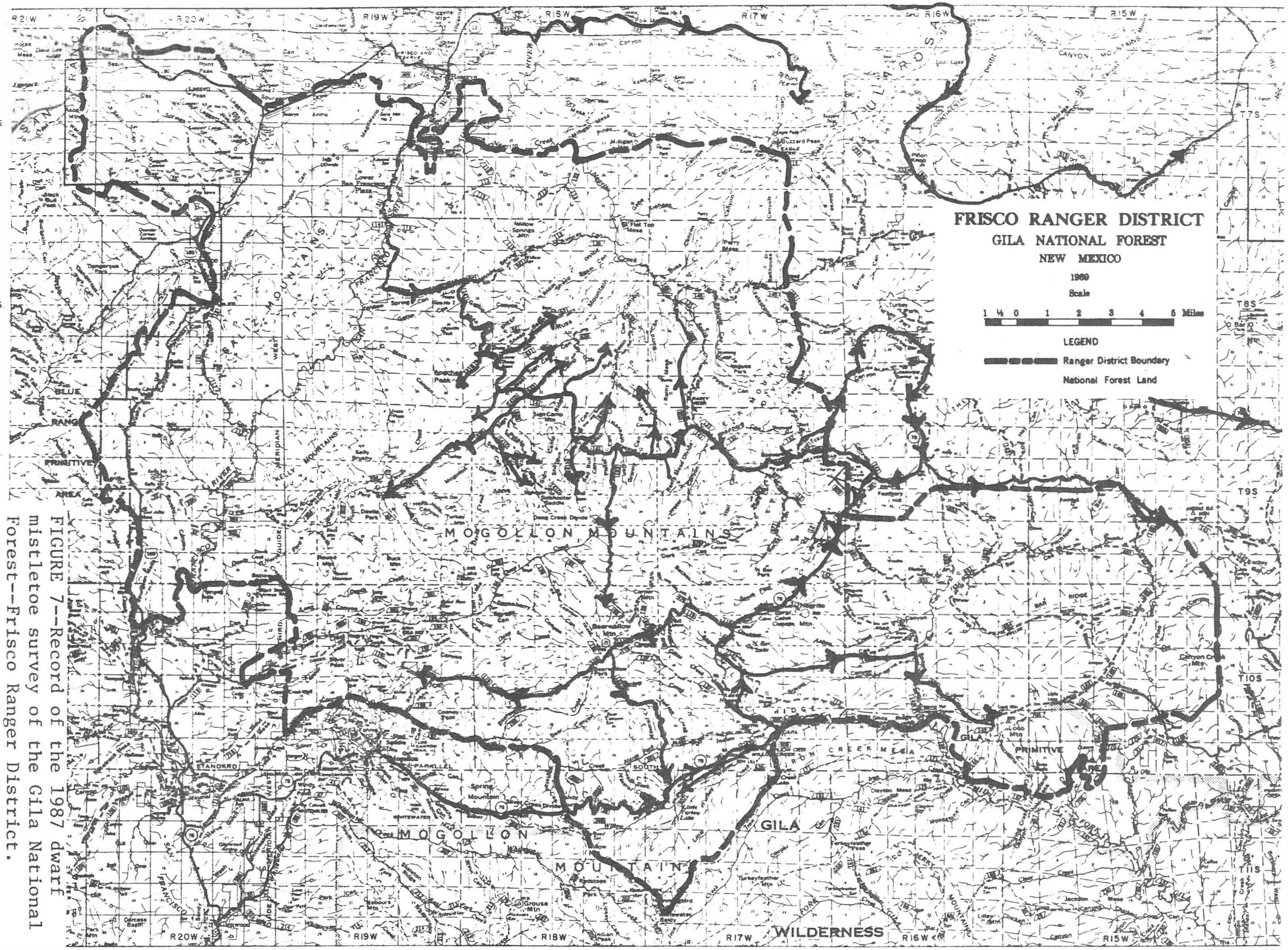
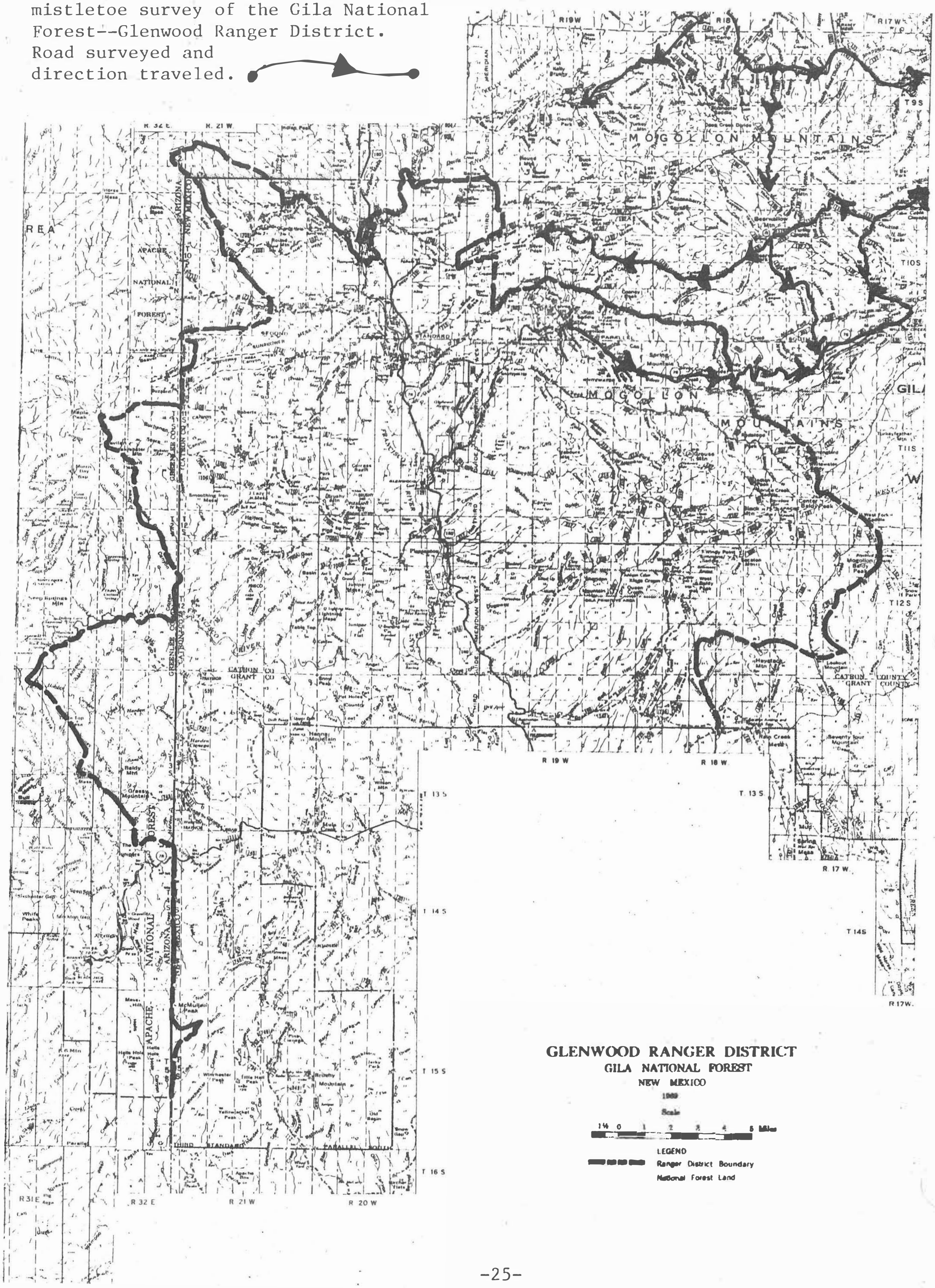


FIGURE 7--Record of the 1987 dwarf mistletoe survey of the Gila National Forest--Frisco Ranger District. Road surveyed and direction traveled.

FIGURE 8--Record of the 1987 dwarf mistletoe survey of the Gila National Forest--Glenwood Ranger District. Road surveyed and direction traveled.



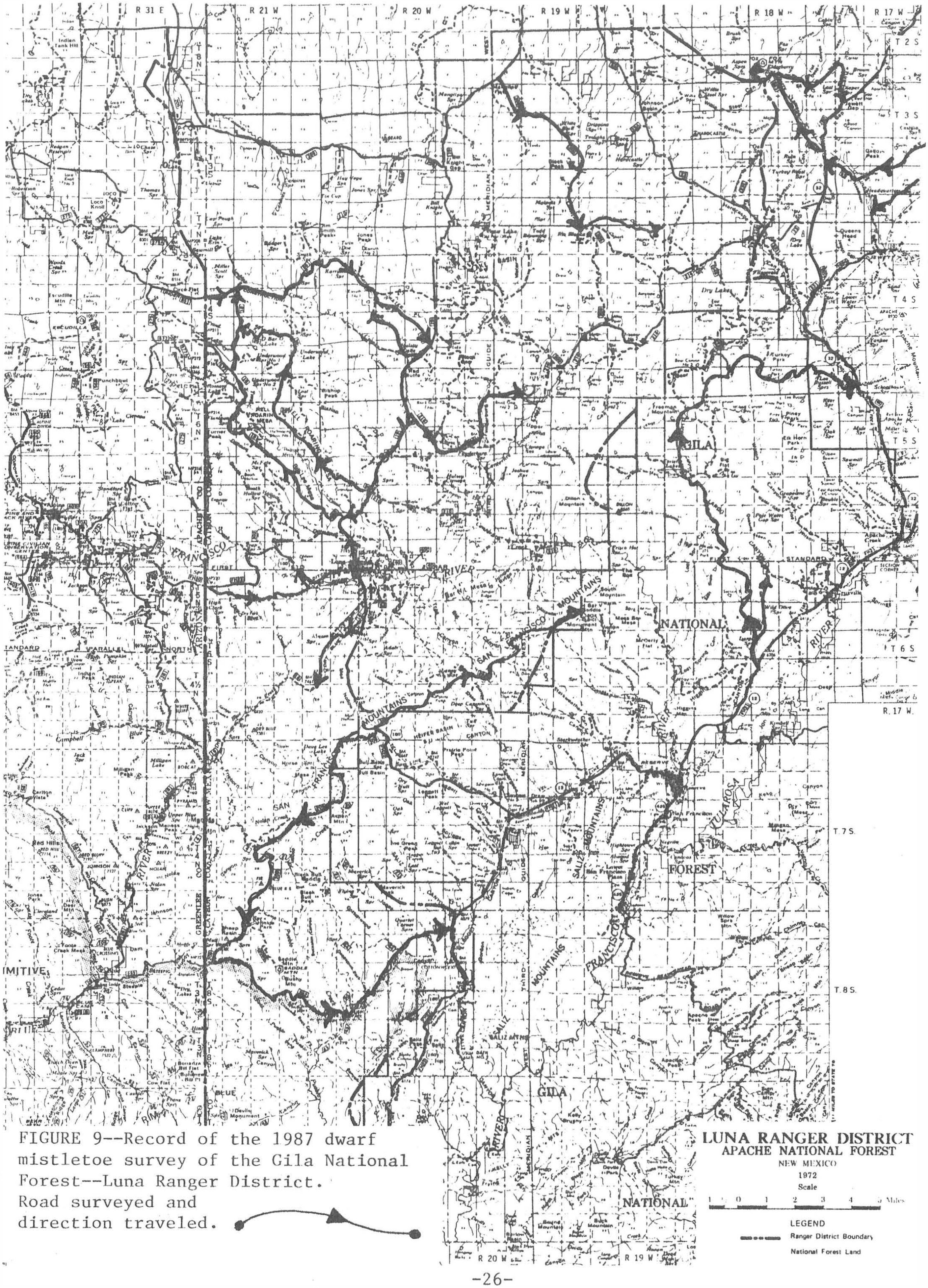


FIGURE 9--Record of the 1987 dwarf mistletoe survey of the Gila National Forest--Luna Ranger District. Road surveyed and direction traveled.

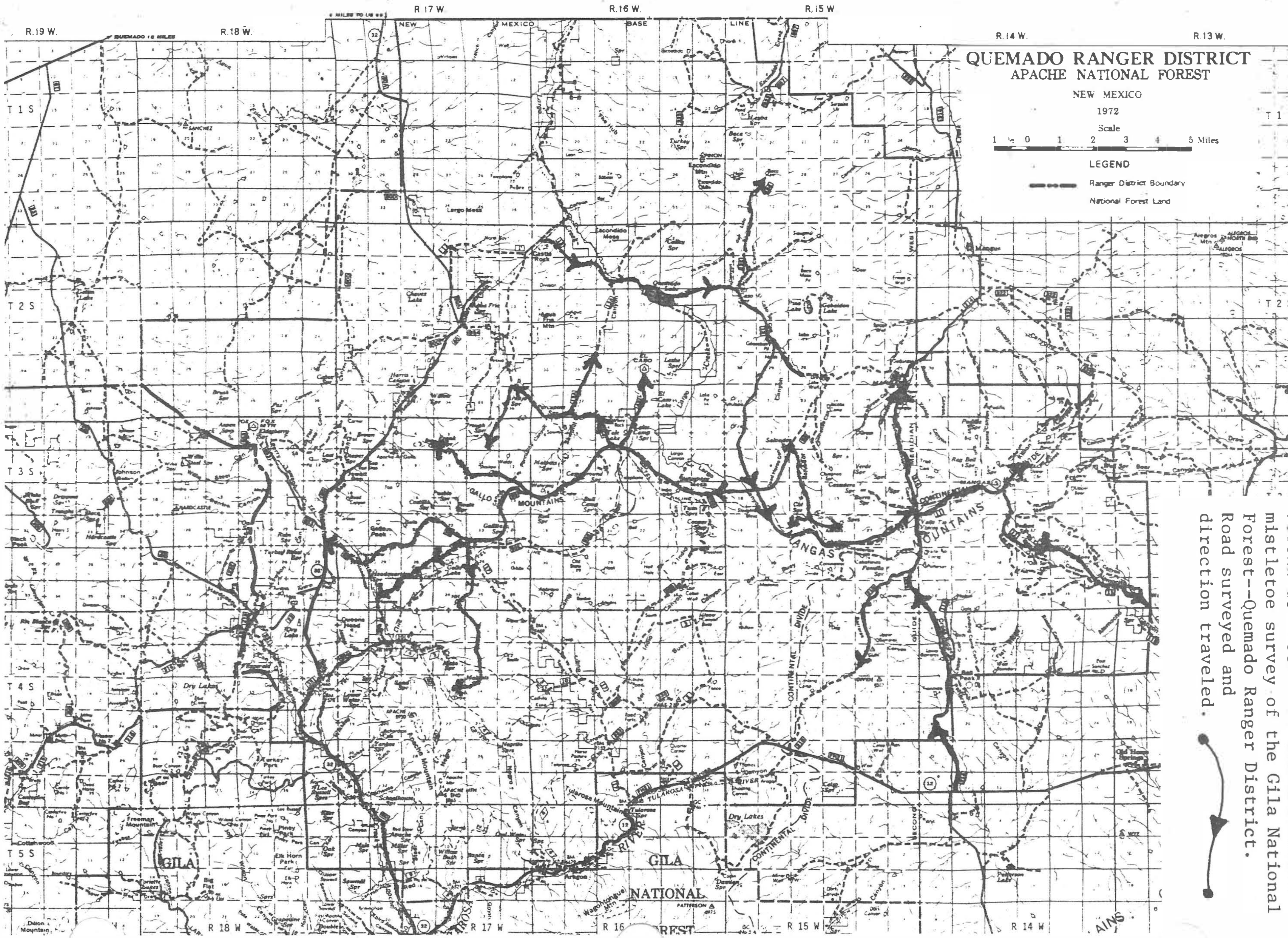


FIGURE 10--Record of the 1987 dwarf mistletoe survey of the Gila National Forest--Quemado Ranger District. Road surveyed and direction traveled.

FIGURE 11--Record of the 1987 dwarf mistletoe survey of the Gila National Forest--Reserve Ranger District. Road surveyed and direction traveled.